NOTE ON THE GEOTROPISM OF ARBACIA LARVÆ.

E. P. LYON.

As soon as the blastulæ of the sea urchin begin to swim, they come to the top of the water. They remain in this locality during the blastula and gastrula stages but become scattered when they reach the pluteus condition.

The gathering at the top is not a light effect, for it takes place in total darkness.

The gathering is not due to lack of oxygen, for the larvæ go up in an inverted test-tube filled with sea water and remain at the top a long time. With the dense gathering of thousands of blastulæ at the top of such a tube the gradient of increasing oxygen supply must be from above downward, yet the larvæ do not go down. A narrow tube closed at one end was nearly filled with water containing young arbacia. An air bubble was introduced into the tube about the middle of its length. The tube was then placed with the closed end directed up. The larvæ went up in both ends of the tube, those above the bubble going directly away from the oxygen supply.

Experiments in tubes kept at constant temperature showed that the gathering was not due to currents in the water. Nor was the gathering due to the larvæ being lighter than sea water. Their specific gravity, on the contrary, is considerably higher, being about 1.060.

That the gathering of larvæ at the top is a true gravity effect is indicated by their moving against a centrifugal force. The best way to demonstrate this is by placing sea water containing many larvæ in rather long (say, 25 cm.), narrow tubes. On rotating these carefully, it will be found that beyond a certain radius (depending on the rate of rotation) the larvæ are precipitated, the acceleration in these parts of the tube being greater than they can swim against. Inside this critical circle the larvæ will be found to have moved toward the axis of rotation and to be gathered in dense crowds.

Paramœcia will rise to the top of a solution of the same density as themselves and in which they have, therefore, no weight. This fact, to my mind, is proof that gravity acts within the organism and not through the relative densities of water and organism. With the larvæ of arbacia, however, I was unable to get any definite gatherings in a solution of gum arabic and sea water of the same density as the larvæ. The viscosity of this medium is so great that such minute ciliated organisms as those under consideration can hardly move through it.

While convinced, therefore, that the gathering of the arbacia larvæ at the top of the water is a gravity effect, I am unable at the present time to say how gravity brings about the response. The possibility that the orientation is purely passive, a buoyancy effect, must be kept in mind, as well as the various theories proposed by Jensen and Davenport. However, on the basis of my paramœcium work, I consider it most probable that gravity acts directly on the cells.

The blastulæ from centrifugalized eggs have all the pigment on one side and are therefore presumably heavier on that side. Later examination shows that this pigment may be in any part of the gastrulæ or plutei. Such larvæ, although, as stated, presumably unbalanced, nevertheless come to the top of the water. I consider this observation opposed to the theory of orientation by buoyancy, for if the heavier portion were always directed down and this portion sustained no relation to the direction of locomotion, the organisms ought to be scattered through the water.